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Data Paper

Time series data of a broadleaved secondary forest in Japan as affected by deer and mass mortality of oak trees

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Abstract

Background

Abandonment of broadleaved secondary forests that have been used for various purposes may cause the loss of biodiversity. Some of these forests suffer from diseases such as Japanese oak wilt. An increasing number of deer also impact some of them. Monitoring and recording the status of such forests is important for their proper management.

New information

This data set provides a concrete example of temporal changes in a temperate broadleaved secondary forest. The forest has been damaged by mass mortality of oak trees caused by Japanese oak wilt disease. In addition, the forest has been under foraging pressure by sika deer (*Cervus nippon* Temminck). The data set can provide information on how such a forest has changed in species composition of the canopy and sub-canopy layers and in species occurrence in the understory layer.

Keywords

broadleaved secondary forest; conifer plantation; deer impact; mass mortality of oak trees

Introduction

The progress of succession due to underuse or abandonment of secondary forests that have been used for various purposes, such as sources of firewood and charcoal wood, may cause loss of biodiversity in Japan (Washitani 2001, Takeuchi 2010) as well as Europe (Rackham 2008, Müllerová et al. 2015). For example, the loss of mosaic land use maintained by human activity can cause habitat loss for various species which depend on the mosaic (Washitani 2001). Some of these forests suffer from diseases. In Japan, the mass mortality of oak trees caused by Japanese oak wilt disease severely affected oak-dominant secondary forests (Kuroda et al. 2012, Nakajima and Ishida 2014). The pathogen is a fungus, *Raffaelea quercivora* Kubono & Shin.Ito, which is carried by a specific beetle, *Platypus quercivorus* Murayama (Kubono and Ito 2002, Kinuura and Kobayashi 2006). Though the pathogen and the vector are both native to Japan, abandonment of the secondary forest in recent decades may be related to the epidemic (Nakajima and Ishida 2014).

In addition, deer impact also affects broadleaved forests in Japan (Takatsuki 2009) and other regions of the world (Côté et al. 2004, Gerhardt et al. 2013). In Japan, an increased number of sika deer (*Cervus nippon* Temminck) has impacted many plantations and natural forests (Takatsuki 2009). Their foraging can suppress regeneration of trees except for deer-unpalatable species (Itô 2015, Itô 2016).

It is important to monitor and record the changes in such forests to manage them properly. This data set provides information on how succession has proceeded in a broadleaf secondary forest in Japan and how the combined effects of the mass mortality of oak trees and deer impacts altered the forest. The data set consists of changes in species composition, stem density and stem diameter at breast height in the canopy and sub-canopy layer from 1993 to 2014, and changes in occurrence of woody species in the understory layer from 1992 to 2014.

General description

Purpose: This study was initiated in 1992 to monitor the dynamics of broadleaved secondary forests adjacent to urban areas. Although the study site also contained a conifer plantation, regeneration of broadleaved species within the plantation was also monitored. After periodic surveys (1993, 1996, 1999, 2002 and 2005) were completed (Itô 2007), mass mortality of oak trees affected the forest, alongside deer impacts. To evaluate the compound effect of both types of damage, the study site was surveyed again in 2014 (Itô 2015, Itô 2016).

Sampling methods

Study extent: This study was conducted in the Ginkakuzi-san (also spelled Ginkakuji-san) National Forest, Kyôto City, Japan. This area is located in the warm-temperate zone. The dominant vegetation of the area had been evergreen oak forest approximately 7000 to 1000 years ago, but secondary forests composed of pines and deciduous oaks increased after that (Takahara 2015). In the late 19th century, the forest around the study site was estimated to be covered with small pines, *Pinus densiflora* Siebold & Zucc., due to human impact (Ogura 2015). After nationalization (in the 1870s), the forest has been protected from felling as a rule. In the 1930s, a mixed forest of pines and deciduous tree species such as *Quercus serrata* Murray covered the site (Osaka Regional Forest Office 1936). However, the forest has not been completely free from felling; e.g., trees were cut for fuel wood during World War II, and part of the forest was converted to conifer (*Cryptomeria japonica* (L.f) D.Don and *Chamaecyparis obtusa* (Siebold & Zucc.) Endl.) plantations in the 1970s. Recently, broadleaved evergreen trees, such as *Symplocos prunifolia* Siebold & Zucc. and *Ilex pedunculosa* Miq., were thinned in some parts of the forest, probably to improve light penetration into the forest. Forest diseases also affected the forest. After the 1960s, pine wilt disease strongly affected the national forest and numerous *P. densiflora* trees died. The responsible pathogen is the nematode *Bursaphelenchus xylophilus* (Steiner & Buhrer) Nickle, which is thought to have been brought from North America (Mamiya 1988). In the last decade, mass mortality of oak trees affected the forest, as described above. In addition, increased numbers of sika deer have affected the forest (Itô 2015, Itô 2016). Though the population density of the deer in the forest is unknown, camera trap data showed that they inhabited the forest in all seasons (Itô 2015).

Sampling description: A 1.05 ha (210 m × 50 m) study site was established in 1992 (Fig. 1). The site was divided into 420 quadrats of 5 × 5 m. The study site mainly consisted of broadleaved secondary forest stands, and the rest was a conifer plantation. The plantation was thinned in 1996, and some of the evergreen broadleaved trees were thinned in the eastern part of the site in 2005. After mass mortality, dead stems of *Q. serrata* were felled, and some stems surrounding the dead stems were also felled. The felled trunks were cut into about 1 m lengths and piled on the floor. The infected wood was covered with plastic sheets and disinfected. The cut stems are denoted in the measurement data file.

Two classes of forest layers were defined: the canopy and sub-canopy layer and the understory layer. Stems in the canopy and sub-canopy layer were defined as having a diameter at breast height (dbh) at least 3.0 cm, and stems in the understory layer were defined as those with a dbh smaller than 3.0 cm or a height shorter than 1.3 m (not including those seedlings and shoots sprouted in the current year). During the period from December 1993 to February 1994, all stems in the canopy and sub-canopy layer were marked, identified by species name, and their dbh measured using a measuring tape with 1 mm precision. After that, dbh was measured in 1996, 1999, 2002, 2005 and 2014 during the non-growing season (October to January of the following year) in the same way. Measurement values in 1999 are missing in the most eastern half of the study site because slope collapse prevention works were conducted near the area.

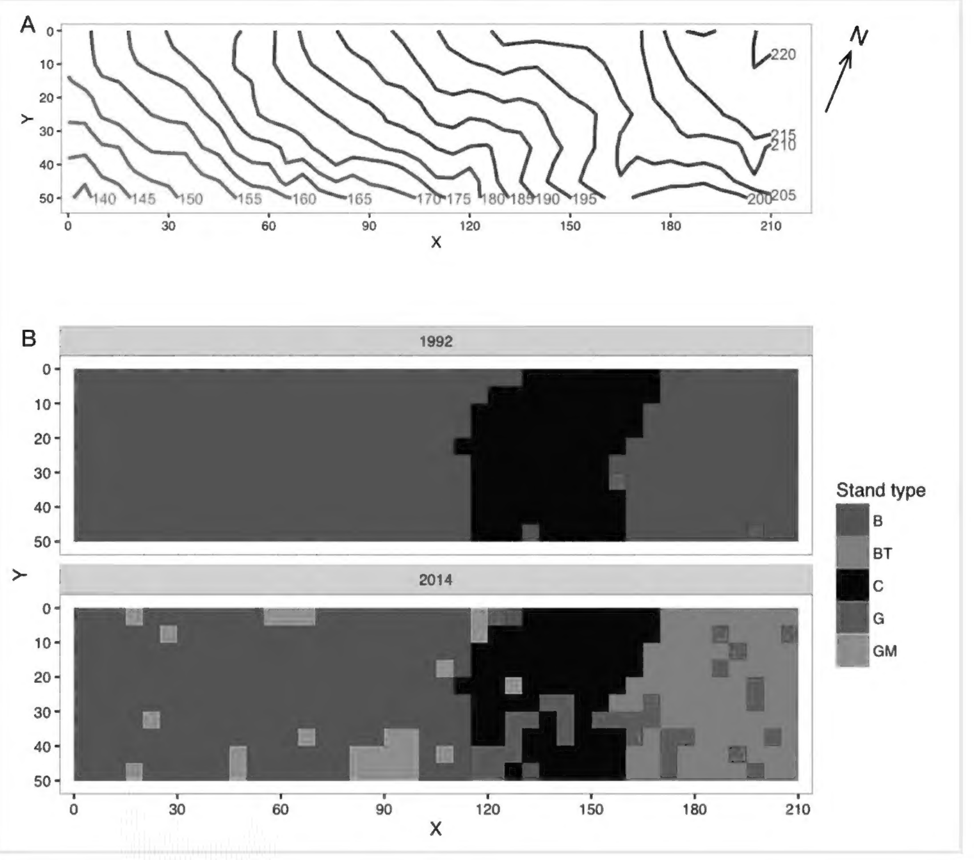

Figure 1.

Outline of the study site. A) Contour map. B) Stand type. B: broadleaved, BT: broadleaved (thinned), C: conifer plantation, G: gap (not related to mass mortality of oak trees), GM: gap created or affected by mass mortality of oak trees. A GM in the conifer plantation was generated by a dead oak stem that remained in the plantation.

In 1992, the species of woody plants found in the understory layer were recorded for each quadrat to obtain the understory species composition of the forest in autumn (September to November). The same survey was conducted again in 2014 (July to November). The dynamics of the half of the study site that solely consisted of broadleaved forest was reported in Itô (2015) and Itô (2016), but this is the first report of the whole study site.

Geographic coverage

Description: Ginkakuzi-san National Forest, Kyôto City, Japan

Coordinates: 35.028 and 35.029 Latitude; 135.802 and 135.800 Longitude.

Taxonomic coverage

Description: The six surveys from 1993 to 2014 found 61 species in the canopy and sub-canopy layer. Table 1 shows their stem density (stems/ha) and basal area (m^2/ha) in 1993 and 2014. *Clerodendrum trichotomum* Thunb. was not included in Table 1, because it had only one stem, which was first found in 2002 but had disappeared in 2005.

Table 1.

Changes in number of stems and basal area for each species in the canopy and sub-canopy layer.

Species	D1993	D2014	B1993	B2014
Chamaecyparis obtusa (Siebold & Zucc.) Endl.	375.2	218.1	8.5E+00	1.2E+01
Quercus glauca Thunb.	412.4	515.2	2.5E+00	4.7E+00
Symplocos prunifolia Siebold & Zucc.	491.4	261.9	4.8E+00	3.7E+00
Cryptomeria japonica (L.f.) D.Don	81.9	61.9	2.3E+00	3.2E+00
Ilex macropoda Miq.	138.1	103.8	3.0E+00	3.1E+00
Ilex pedunculosa Miq.	193.3	141.0	2.9E+00	2.3E+00
Gamblea innovans (Siebold & Zucc.) C.B.Shang, Lowry & Frodin	361.0	81.9	3.0E+00	1.5E+00
Quercus serrata Murray	37.1	14.3	2.8E+00	1.5E+00
Chengiopanax sciadophylloides (Franch. & Sav.) C.B.Shang et J.Y.Huang	78.1	20.0	1.5E+00	8.1E-01
Cleyera japonica Thunb.	70.5	386.7	8.7E-02	8.1E-01
Carpinus laxiflora (Siebold & Zucc.) Blume	29.5	18.1	7.6E-01	7.8E-01
Cerasus jamasakura (Siebold ex Koidz.) H.Ohba	12.4	6.7	3.4E-01	6.3E-01
Photinia glabra (Thunb.) Maxim.	79.0	85.7	4.1E-01	5.3E-01
Carpinus tschonoskii Maxim.	8.6	5.7	3.7E-01	5.1E-01
Wisteria floribunda (Willd.) DC.	119.0	90.5	3.3E-01	4.9E-01
Padus grayana (Maxim.) C.K.Schneid.	17.1	10.5	2.6E-01	3.9E-01
Abies firma Siebold & Zucc.	3.8	2.9	1.8E-01	3.4E-01
Eurya japonica Thunb. var. *japonica*	112.4	246.7	1.2E-01	3.3E-01
Lyonia ovalifolia (Wall.) Drude var. *elliptica* (Siebold & Zucc.) Hand.-Mazz.	61.9	19.0	3.9E-01	2.3E-01
Albizia julibrissin Durazz.	13.3	1.9	4.1E-01	2.2E-01
Aria japonica Decne.	1.0	1.0	1.2E-01	1.6E-01
Acer palmatum Thunb.	2.9	6.7	1.2E-01	1.5E-01
Ilex chinensis Sims	1.9	1.9	2.2E-01	1.4E-01
Fraxinus sieboldiana Blume	22.9	10.5	2.0E-01	1.3E-01
Mallotus japonicus (L.f.) Müll.Arg.	4.8	1.9	1.5E-01	1.3E-01
Camellia japonica L.	25.7	27.6	5.6E-02	1.2E-01
Styrax japonica Siebold & Zucc.	35.2	9.5	3.0E-01	1.2E-01
Clethra barbinervis Siebold & Zucc.	22.9	10.5	2.5E-01	1.0E-01

Dendropanax trifidus (Thunb.) Makino ex H.Hara	4.8	4.8	8.8E-02	9.9E-02
Cinnamomum camphora (L.) J.Presl	1.0	3.8	7.8E-03	9.6E-02
Ilex rotunda Thunb.	1.9	1.9	5.2E-02	8.8E-02
Diospyros kaki Thunb.	5.7	1.9	8.3E-02	8.2E-02
Laurocerasus spinulosa (Siebold & Zucc.) C.K.Schneid.	3.8	1.9	2.0E-01	8.0E-02
Ligustrum japonicum Thunb.	15.2	17.1	3.3E-02	6.4E-02
Idesia polycarpa Maxim.	1.9	1.0	2.2E-02	6.3E-02
Alnus sieboldiana Matsum.	2.9	1.0	1.9E-01	6.2E-02
Zanthoxylum ailanthoides Siebold & Zucc.	3.8	1.9	1.8E-01	4.8E-02
Castanopsis cuspidata (Thunb.) Schottky	1.0	10.5	1.6E-02	4.7E-02
Vaccinium bracteatum Thunb.	17.1	4.8	3.6E-02	3.9E-02
Euscaphis japonica (Thunb.) Kanitz	6.7	1.0	8.0E-03	2.5E-02
Toxicodendron sylvestre (Siebold & Zucc.) Kuntze	2.9	1.0	3.4E-02	1.1E-02
Magnolia compressa Maxim.	0.0	1.0	0.0E+00	3.7E-03
Rhododendron reticulatum D.Don ex G.Don	9.5	3.8	9.2E-03	3.6E-03
Osmanthus heterophyllus (G.Don) P.S.Green	3.8	2.9	4.9E-03	3.5E-03
Pieris japonica (Thunb.) D.Don ex G.Don	5.7	1.0	1.1E-02	3.2E-03
Symplocos sawafutagi Nagam.	1.9	2.9	1.6E-03	3.2E-03
Pourthiaea villosa (Thunb.) Decne. var. *villosa*	1.0	1.0	8.6E-04	2.5E-03
Triadica sebifera (L.) Small	0	1.0	0.0E+00	2.2E-03
Acer crataegifolium Siebold & Zucc.	1.9	0	3.9E-03	0.0E+00
Alnus firma Siebold & Zucc.	1.0	0	2.3E-03	0.0E+00
Amelanchier asiatica (Siebold & Zucc.) Endl. ex Walp.	2.9	0	1.1E-02	0.0E+00
Aucuba japonica Thunb. var. *japonica*	1.0	0	9.7E-04	0.0E+00
Castanea crenata Siebold & Zucc.	1.9	0	3.0E-02	0.0E+00
Cinnamomum yabunikkei H.Ohba	1.0	0	1.7E-03	0.0E+00
Elaeagnus glabra Thunb.	1.0	0	2.3E-03	0.0E+00
Ilex crenata Thunb.	1.0	0	8.6E-04	0.0E+00
Ilex micrococca Maxim.	1.0	0	1.3E-01	0.0E+00
Pinus densiflora Siebold & Zucc.	20.0	0	1.5E+00	0.0E+00
Quercus acutissima Carruth.	1.0	0	1.7E-03	0.0E+00

Toxicodendron trichocarpum (Miq.) Kuntze	23.8	0	5.8E-02	0.0E+00
Total	2961.4	2428.3	3.91E+01	3.99E+01

The most abundant species was *Symplocos prunifolia* Siebold & Zucc. in 1993, but *Quercus glauca* Thunb. surpassed it by 2014. The dominant species in the basal area was consistently *Chamaecyparis obtusa*, which occupied most of the plantation area of the study site. *Quercus serrata* decreased in density from 37.1 to 14.3 stems/ha and in basal area from 2.8 to 1.5 m^2/ha (Table 1, Fig. 2).

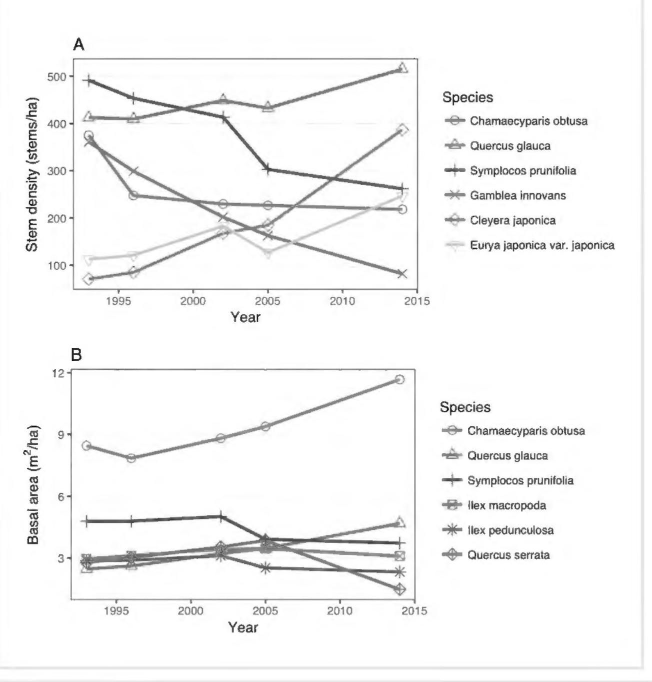

Figure 2.

Changes in dominance of major species. A: stem density, and B: basal area.

In the understory layer, 88 woody species were found over the two surveys in 1992 and 2014 excluding unidentified species. Table 2 shows the species and the number of quadrats where they were found. *Quercus glauca* was the most frequent species in both 1992 and 2014. *Symplocos prunifolia* increased in the number of quadrats from 75 to 274. This may related to gap formation by oak tree deaths and thinning of upper trees as well as the deer-unpalatable trait of the species.

Table 2.

Changes in number of quadrats where each species was found (out of 420 quadrats) in the understory layer.

Species	1992	2014
Quercus glauca Thunb.	361	392
Eurya japonica Thunb. var. *japonica*	362	304
Symplocos prunifolia Siebold & Zucc.	75	274
Cryptomeria japonica (L.f.) D.Don	190	163

Photinia glabra (Thunb.) Maxim.	168	114
Cryptomeria japonica (L.f.) D.Don	26	79
Ilex pedunculosa Miq.	36	72
Carpinus laxiflora (Siebold & Zucc.) Blume	15	58
Chamaecyparis obtusa (Siebold & Zucc.) Endl.	13	58
Styrax japonica Siebold et Zucc.	4	53
Camellia japonica L.	64	51
Mallotus japonicus (L.f.) Müll.Arg.	2	46
Ilex macropoda Miq.	6	45
Cleyera japonica Thunb.	7	44
Celtis sinensis Pers.	0	40
Zanthoxylum ailanthoides Siebold & Zucc.	0	37
Osmanthus heterophyllus (G.Don) P.S.Green	26	35
Carpinus tschonoskii Maxim.	1	29
Fraxinus sieboldiana Blume	0	28
Callicarpa mollis Siebold & Zucc.	13	25
Castanopsis cuspidata (Thunb.) Schottky	19	22
Ilex micrococca Maxim.	0	22
Zelkova serrata (Thunb.) Makino	2	20
Gamblea innovans (Siebold & Zucc.) C.B.Shang, Lowry & Frodin	24	18
Aphananthe aspera (Thunb.) Planch.	1	18
Pinus densiflora Siebold & Zucc.	2	17
Cinnamomum yabunikkei H.Ohba	26	16
Quercus serrata Murray	14	16
Ilex crenata Thunb.	143	15
Abelia serrata Siebold & Zucc.	17	15
Acer palmatum Thunb.	9	15
Chengiopanax sciadophylloides (Franch. & Sav.) C.B.Shang & J.Y.Huang	13	14
Triadica sebifera (L.) Small	0	14
Ligustrum japonicum Thunb.	68	13
Aria japonica Decne.	2	12

Idesia polycarpa Maxim.	0	12
Rubus microphyllus L.f.	0	11
Laurocerasus spinulosa (Siebold & Zucc.) C.K.Schneid.	20	10
Pieris japonica (Thunb.) D.Don ex G.Don	12	10
Rhododendron reticulatum D.Don ex G.Don	4	7
Albizia julibrissin Durazz.	0	7
Cinnamomum camphora (L.) J.Presl	0	7
Rhododendron macrosepalum Maxim.	26	6
Cornus macrophylla Wall.	0	6
Aucuba japonica Thunb. var. *japonica*	211	5
Vaccinium bracteatum Thunb.	61	5
Toxicodendron trichocarpum (Miq.) Kuntze	42	5
Lyonia ovalifolia (Wall.) Drude var. *elliptica* (Siebold & Zucc.) Hand.-Mazz.	20	5
Abies firma Siebold & Zucc.	3	5
Symplocos sawafutagi Nagam.	2	5
Ardisia crenata Sims	3	4
Rubus buergeri Miq.	64	3
Lindera umbellata Thunb.	39	3
Elaeagnus pungens Thunb.	4	3
Rubus palmatus Thunb. var. *palmatus*	1	3
Rubus phoenicolasius Maxim.	0	3
Acer crataegifolium Siebold & Zucc.	4	2
Padus grayana (Maxim.) C.K.Schneid.	3	2
Damnacanthus indicus C.F.Gaertn. var. *indicus*	2	2
Aralia elata (Miq.) Seem.	0	2
Cerasus jamasakura (Siebold ex Koidz.) H.Ohba	0	2
Ilex chinensis Sims	0	2
Rosa multiflora Thunb.	0	2
Rubus hirsutus Thunb.	0	2
Unidentified	0	2
Vaccinium hirtum Thunb.	6	1

Vaccinium smallii A.Gray	6	1
Castanea crenata Siebold & Zucc.	2	1
Clerodendrum trichotomum Thunb.	2	1
Illicium anisatum L.	1	1
Broussonetia monoica Hance	0	1
Epigaea asiatica Maxim.	0	1
Ilex integra Thunb.	0	1
Zanthoxylum piperitum (L.) DC.	0	1
Viburnum erosum Thunb.	11	0
Ardisia japonica (Thunb.) Blume	10	0
Trachycarpus fortunei (Hook.) H.Wendl.	7	0
Euscaphis japonica (Thunb.) Kanitz	6	0
Rhododendron kaempferi Planch. var. *kaempferi*	6	0
Dendropanax trifidus (Thunb.) Makino ex H.Hara	4	0
Neolitsea sericea (Blume) Koidz.	4	0
Camellia sinensis (L.) Kuntze	3	0
Carpinus sp.	2	0
Diospyros kaki Thunb.	2	0
Neolitsea sp.	2	0
Pourthiaea villosa (Thunb.) Decne. var. *villosa*	2	0
Cephalotaxus harringtonia (Knight ex Forbes) K.Koch var. *harringtonia*	1	0
Elaeagnus sp.	1	0
Fatsia japonica (Thunb.) Decne. & Planch.	1	0
Quercus acutissima Carruth.	1	0
Symplocos lancifolia Siebold & Zucc.	1	0
Vaccinium japonicum Miq.	1	0
Vaccinium sp.	1	0

Temporal coverage

Data range: 1992-9-18 - 2014-12-19.

Usage rights

Use license: Open Data Commons Attribution License

IP rights notes: Forestry and Forest Products Research Institute (Matsunosato 1, Tsukuba 305-8687, Japan) has ownership of this data set.

Data resources

Data package title: Forest dynamics data in the Ginkakuzi-san National Forest, Kyôto, Japan

Number of data sets: 6

Data set name: Site data

Download URL: http://dx.doi.org/10.5061/dryad.7f399

Data format: CSV

Description: Location and stand type of each quadrat.

Column label	Column description
X	Position of the northwest corner of the quadrat along the X axis (m).
Y	Position of the northwest corner of the quadrat along the Y axis (m).
Type1992	Stand type of the quadrat (B: broadleaved forest, C: conifer plantation, G: gap).
Type2014	Stand type of the quadrat (B: broadleaved forest, C: conifer plantation, G: gap (not related to mass mortality of oak trees), GM: gap created or affected by the mass mortality of oak trees).

Data set name: Elevation data

Download URL: http://dx.doi.org/10.5061/dryad.7f399

Data format: CSV

Description: Elevation of grid points (5 m × 5 m) of the study site.

Column label	Column description
X	Location along the X axis (m).
Y	Location along the Y axis (m).
Elevation	Elevation (m; precision: 0.1 m).

Data set name: Stem data

Download URL: http://dx.doi.org/10.5061/dryad.7f399

Data format: CSV

Description: List of all stems found from 1993 to 2014.

Column label	Column description
Indv	Individual ID
Stem	Stem ID
X	Position of the northwest corner of the quadrat where the stem was located along the X axis (m).
Y	Position of the northwest corner of the quadrat where the stem was located along the Y axis (m).
X1	Position of the stem along the X axis (m; precision: 0.1 m).
Y1	Position of the stem along the X axis (m; precision: 0.1 m).
Species	Species of the stem.
Start	Year when the stem was first marked.
End	Year when the stem was last found alive (NA denotes that the stem was still alive in 2014).

Data set name: Stem measurement data

Download URL: http://dx.doi.org/10.5061/dryad.7f399

Description: Measurements of dbh for each stem from 1993 to 2014. Measurement values in 1999 are missing in the most eastern half of the study site because slope collapse prevention works were conducted near the area.

Column label	Column description
Stem	Stem ID
Year	Year of the measurement.
DBH	Diameter at breast height (cm; precision: 0.1 cm). NA denotes missing data.
Comment	Comment on the measurement.

Data set name: Understory data

Download URL: http://dx.doi.org/10.5061/dryad.7f399

Data format: CSV

Description: Occurrence of woody species in the understory layer for each quadrat.

Column label	Column description
Year	Survey year.
X	Position of the northwest corner of the quadrat along the X axis (m).
Y	Position of the northwest corner of the quadrat along the Y axis (m).
Species	Species found in the quadrat.

Data set name: Occurrence data of woody species

Download URL: http://www.gbif.org/dataset/d5d92045-cbd8-453a-9b4e-25a7b74c51c5

Data format: Darwin Core Archive

Description: Occurrence data of woody species in the Ginkakuzi-san National Forest.

Column label	Column description
occurrenceID	An identifier for the Occurrence.
modified	The most recent date-time on which the resource was changed.
rights	Information about who can access the resource or an indication of its security status.
rightsHolder	A person or organization owning or managing rights over the resource.
institutionCode	The name (or acronym) in use by the institution having custody of the object(s) or information referred to in the record.
collectionCode	The name, acronym, coden, or initialism identifying the collection or data set from which the record was derived.
datasetName	The name identifying the data set from which the record was derived.
basisOfRecord	The specific nature of the data record.
catalogNumber	An identifier (preferably unique) for the record within the data set or collection.
year	The four-digit year in which the Event occurred, according to the Common Era Calendar.
country	The name of the country or major administrative unit in which the Location occurs.
countryCode	The standard code for the country in which the Location occurs.
verbatimLocality	The original textual description of the place.
decimalLatitude	The geographic latitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of the geographic center of a Location.
decimalLongitude	The geographic longitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of the geographic center of a Location.

coordinateUncertaintyInMeters	The horizontal distance (in meters) from the given decimalLatitude and decimalLongitude describing the smallest circle containing the whole of the Location.
scientificName	The full scientific name, with authorship and date information if known.
kingdom	The full scientific name of the kingdom in which the taxon is classified.
phylum	The full scientific name of the phylum or division in which the taxon is classified.
family	The full scientific name of the family in which the taxon is classified.
genus	The full scientific name of the genus in which the taxon is classified.
specificEpithe	The name of the first or species epithet of the scientificName.
infraspecificEpithet	The name of the lowest or terminal infraspecific epithet of the scientificName, excluding any rank designation.

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